(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 922 788 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
16.06.1999 Bulletin 1999/24

(21) Application number: 97942326.6

(22) Date of filing: 12.09.1997

(51) Int. Cl.6: C25B 9/00, C02F 1/461

(86) International application number:
PCT/RU97/00281

(87) International publication number:
WO 98/40536 (17.09.1998 Gazette 1998/37)

(84) Designated Contracting States:
BE CH ES GB IE LI

(30) Priority: 11.03.1997 RU 97103204

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(54) ELECTROCHEMICAL INSTALLATION

(57) Disclosed is an electrochemical installation, the application of which is the electrochemical processing of aqueous solutions and the production of gases. The invention owes its simplicity of structure to the creation of a spiral motion of electrolytes within the electrode chambers, by means of the presence of inclined canals and spiral-shaped guiding elements in the bushings. The installation creates a new property, consisting in the prolonged action of the electrolysis process on the aqueous solutions being treated. During operation of the installation, the initial solution passes into the pipes (4, 5) of the lower bushing (3), where the presence of the spiral-shaped guiding elements (13, 15) generates the spiral motion of the electrolytes, said motion being maintained in the electrode chambers (30, 29). At the end of the electrochemical process, the resultant solutions and gases pass into the upper bushing (7) where, under the effect of the spiral motion, they are drawn off from the corresponding chambers through outlet pipes (9, 8).

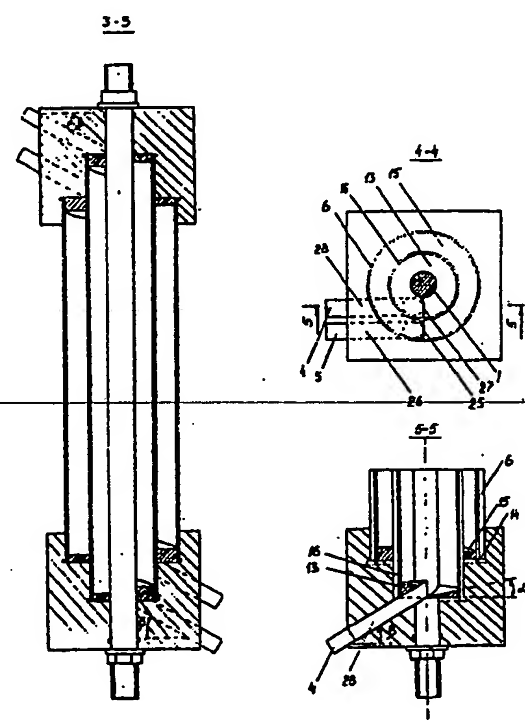

FIG. 3

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Description

[0001] The invention falls into the field of chemical technology in particular electrochemical processing of water solutions and gas production and can be used to clean and disinfect water, so as to manufacture disinfecting, sterilizing and cleaning solutions.

[0002] Coaxial activator exists where water solution to be processed flows downwards through valves in the upper part of the electrochemical activator. Electrochemically received anolyte and catholyte leave the activator by separate channels in the lower part of the activator (1). The disadvantage of the activator is the possibility of gas filled zones formation in the upper part of electrode chambers, so as considerable losses of electricity due to counter-flow of electrochemically obtained gases and electrolytes. Electrolysis block of the potable water producing installation constructed of cylindrical elements exists, where water to be electrolyzed is supplied to both chambers in the lower part of the electrolysis block, and the anolyte and catholyte received are removed separately from the upper parts of the electrolysis block chambers (2). The disadvantage of this installation is considerably high hydrodynamic resistance and impossibility to create independent circulation circuits of anolyte and catholyte. Installation of electrochemical water processing exists, which basic element is a coaxial electrolyzer with an input bush for separated input of solutions to anodic and cathodic chambers, and an output bush to remove separately the products of electrolysis. The bushes are located in the upper and lower parts of the installation correspondingly. The disadvantage of the installation is the complex structure, low turbulization of electrolyte flows in electrode chambers, so as complicated removal of electrochemically received gases from the chambers.

[0003] The problem to be resolved by the present invention is improvement of the installation efficiency. Technical result that can be received if the invention is realized consists in simple construction of the electrochemical installation, achieved by creation of a spiral movement of electrolytes in the electrode chambers. This movement leads to turbulization of the electrolytes in the chambers of the installation, prolongs influence of electrolysis process over elementary amounts of the processed water solutions, simplifies removal of gaseous and liquid products of electrolysis and reduces possible formation of gas-filled zones in the upper points of electrode chambers. The electrochemical installation consists of vertical coaxial cylindrical and rod electrodes and coaxial ion-exchange diaphragm, placed between them. Both electrodes and diaphragm are mounted in dielectric bushes. The space between cylindric electrode and diaphragm, and between diaphragm and the rod electrode form electrode chambers, whose geometric dimensions satisfy the following ratio:

$$0.65\,\frac{D_B}{D_S} \le \frac{K}{\ln(L)} \le 25.00\,\frac{D_B}{D_S}$$

$$0.60 \le \frac{S_S}{S_B} \le 1.50$$

where

- K - distance between electrodes, mm;
- L - length of working part of electrode chamber (distance between electrolyte input and output openings), mm
- D_S - inner diameter of cylindric electrode, mm;
- D_D - inner diameter of diaphragm, mm

$$D_D = 0.15 \div 0.8\,D_S$$

- D_B - diameter of rod electrode, mm

$$D_B = 0.10 \div 0.7\,D_S$$

- S_S and S_B - areas of electrode chamber's transversal section of cylindric and rod electrodes respectively, mm^2.

[0004] The electrode chambers are hermetically sealed by rubber gaskets placed in the bushes under the diaphragm and cylindrical electrode, and rubber-sealing ring around the rod electrode. The section of the rod electrode is uniform along from the upper threading to the lower threading. The bush has coaxial opening for the rod electrode, two hollow cylinders for ion exchange diaphragm and cylindric electrode installation, their diameters not less than outer diameters of the diaphragm and cylindric electrode correspondingly. The bush also has two pipe connections. The pipe connections together with coaxial connection channels whose right guide enters the electrode chambers tangentially to the inner generatrix of the base of corresponding cylinder at the angle $0° < \beta < 90°$ form along with the opening in the guiding element input and output spiral channels for electrolytes to enter and leave circulation circuits. The angle of elevation of the spiral guiding element corresponds to the ratio $0° < \alpha < 90°$. Width of the spiral guiding element correlates to the width of the electrode chamber, in the circulation circuit whereof it is installed in the bush. Diameters of the opening in the spiral guiding element and of the connection channel do not exceed the width of electrode chamber they has been designed for. In order to guarantee stable and effective spiral movement in the electrode chambers the pipe connections, connection channels and openings in the guiding element of the upper bush may be displaced from the pipe connections, connection channels and openings in the guiding element of the lower bush by the angle $0° < \gamma < 360°$ in plane. Introducing into the electrochemical installation bushes which due to inclined chan-

nels and spiral guiding elements placed form spiral movement of electrolytes in electrode chambers we receive a new characteristic, consisting in simple construction of the electrochemical installation, turbulization of the electrolytes in the chambers of the installation, prolonged influence of electrolysis process over elementary amounts of the processed water solutions, simple and effective removal of gaseous and liquid products of electrolysis from the installation. The helical motion results from the sum of translational, rotary and deformational motion. It characterizes vortex flow of liquid where the environment turbulization is realized by rotary and translational motion. Elevating the electrolyte from bottom to top the rotary motion somehow reduces its value due to increased deformation motion. But at high speeds Re>2300 this reduction is little in the proposed electrochemical installation. The rotary motion allows increasing considerably the period of electrolysis influence comparing to straight-line or similar motion of water solutions due to the spiral travel of the processed water solution along the anodic and cathodic chambers of the installation. Construction of the bushes containing the spiral guiding elements allows realizing of the rotary motion benefits, facilitates electrolyte in-flow to the installation and removal of the products when the electrolysis is completed.

[0005] The installation consists of the rod electrode 1 with threading in the upper and lower parts, allowing drawing together the electrochemical installation and hermetically sealing it by circulation circuits of the electrode chambers with the gasket 10 and nut 2. The destination of both internal and external electrode chambers depends on the technology of water processing and may be switched to anodic or cathodic by changing of polarity. Circulation circuit of the outer electrode chamber includes the following way of electrolyte's movement: input connection pipe 5 in the lower bush 3; - connection channel 26, passing through the bush at an angle β and entering the electrode chamber with its extreme right guide tangentially to the inner generatrix of the base of the larger cylinder; - opening 25 in the spiral guiding element 15; - bush outlet to the electrode chamber 29, made of the wall of cylindric electrode 6 and the wall of the ion exchange diaphragm 16; - inlet of the upper bush 7; - surface of the spiral guiding element 17; - opening 24 in the guiding element 17; - connection channel 23 passing the bush 7 at an angle β; - output connecting pipe of the electrolysis products 8. Circulation circuit of the inner electrode chamber includes the following way of electrolyte's movement input connection pipe 4 in the lower bush 3; - connection channel 28, passing through the bush at an angle β and entering the electrode chamber with its extreme right guide tangentially to the inner generatrix of the base of the smaller cylinder; - opening 27 in the spiral guiding element 13; - surface of the spiral guiding element 13; - bush outlet to the electrode chamber 30, made by the rod electrode 1 and the wall of the ion exchange diaphragm 16; - inlet of the upper bush 7; - surface of the spiral guiding element 19; - opening 22 in the guiding element 19; - connection channel 21 passing through the bush 7 at an angle β; - output connecting pipe of the electrolysis products 9. The electrode chambers are hermetically sealed with rubber gaskets 12, 14, 18, 20 placed under the ion exchange diaphragm 16 and the cylindric electrode 6, so as with sealing ring 11 around the rod electrode 1.

[0006] Figure 1 shows the general view of the installation, figure 2 - sectional views by 1-1 and 2-2. Figure 3 presents sectional views by 3-3, 4-4 and 5-5. 1 - electrode with threading in the upper and lower parts; 2 - nut; 3 - lower bush; 4, 5 - input connection pipes of the lower bush; 6 - cylindric electrode; 7 - upper bush; 8, 9 - output connection pipe of the electrolysis products; 10 - gasket; 11 - sealing ring; 12, 14, 18, 20 - rubber gaskets; 13 - surface of the guiding element; 15 - surface of the guiding element, 16 - ion exchange diaphragm; 17 - guiding element; 19 - surface of the spiral guiding element; 21 - connection channel passing through the bush; 22 - opening; 23 - connection channel passing the bush 7 at an angle β; 24 - opening in the guiding element 17; 25 - opening in the spiral guiding element 13; 26 - connection channel passing the bush at an angle β; 27 - opening in the spiral guiding element 13; 28 - connection channel passing the bush at an angle β; 29, 30 - electrode chambers.

[0007] The crude solution enters the connection pipes 4 and 5 of the lower bush 3, where due to the spiral guiding elements 13 and 15 screw motion of the electrolyte is formed. The motion persists in the chambers 30 and 29. After processing in the electrode chambers the electrochemically produced solutions and gases flow to the upper bush 7, where they are removed from corresponding chambers through the connecting pipes 8 and 9 by the screw motion.

[0008] The present invention can be used to purify and disinfect water, so as to produce disinfecting, sterilizing and cleaning solutions.

REFERENCE CITED

[0009]

1. SU, Inventors certificate № 20511114, C02F 1/46, 1995.
2. Application of Japan № 63-8831, CO2F 1/46, 1988.
3. SU, inventors certificate № 2042639, CO2F 1/46, 1995.
4. R.R. Chuguev. Hydraulics, Energoizdat, Leningrad, 1982, 78 p.

Claims

1. An electrochemical plant comprising vertical coaxial cylindrical and core electrodes located dielectric

sleeves, a membrane coaxially arranged in said sleeves between said electrodes into electrode chambers, wherein said dielectric sleeves with a through inside hole for a core electrode, two hollow coaxial cylinders for the said membrane and the said cylindrical electrode are made with pipes and coaxial connecting canals entering said electrode chambers with their right edge guides tangentially to inner base elements of corresponding cylinders at angle $0° < \beta < 90°$, are equipped with spiral guiding elements, having in the lower part a hole extending the said connecting canal, to generate helical motion in said electrode chambers and to remove electrolysis products from upper parts of said electrode chambers being separated from each other by an ion exchange membrane so that geometric sizes of said electrode chambers fit the relations:

$$0.65\,\frac{D_B}{D_S} \le \frac{K}{\ln(L)} \le 25.00\,\frac{D_B}{D_S};$$

$$0.60 \le \frac{S_S}{S_B} \le 1.50;$$

where

K - electrode spacing, mm;

L - lenght of the electrode chamber working section (distance between holes of electrolyte outlet and inlet to the chamber), mm;

D_S - inner diameter of a cylindrical electrode, mm:

D_D - membrane inner diameter, mm;

$$D_D = 0.15 - 0.8\,D_S$$

D_B - core electrode diameter, mm;

$$D_B = 0.10 - 0.7\,D_S$$

S_S and S_B - cross-section areas of electrode chambers of cylindrical and core electrodes, respectively, mm^2.

2. A plant according to claim 1, wherein the said core electrode from thread in upper part to thread in the lower part is of uniform cross-section.

3. A plant according to claims 1- 2, wherein the ion exchange membrane and the cylindrical electrode rest on rubber gaskets in said sleeves.

4. A plant according to claims 1 - 3, wherein the slope of the spiral guiding element fits the relation $0° < \alpha < 90°$, the width of the spiral guiding element conforms to the width of the electrode chamber in whose circulation loop inside the sleeve this element is installed.

5. A plant according to claims 1 - 4, wherein said pipes, said connecting canals and said holes in the guiding element of the upper sleeve can be shifted in plan from said pipes, said connecting canals and said holes in the guiding element of the lower sleeve by an angle satisfying the relation $0 \le \gamma \le 360$.

6. A plant according to claims 1 - 5, wherein inside said sleeves diameters of hollow cylinders intended for the membrane and the cylindrical electrode are no less than outer diameters of the membrane and the cylindrical electrode, respectively.

7. A plant according to claims 1 - 6, wherein inner diameters of the connecting canals in the sleeves and of the holes in the spiral guiding elements do not exceed the width of the electrode chambers they are intended for.

8. A plants according to claims 1 - 7, wherein the connecting canals in the upper sleeve can be made with different angles β of inlet to the electrode chambers.

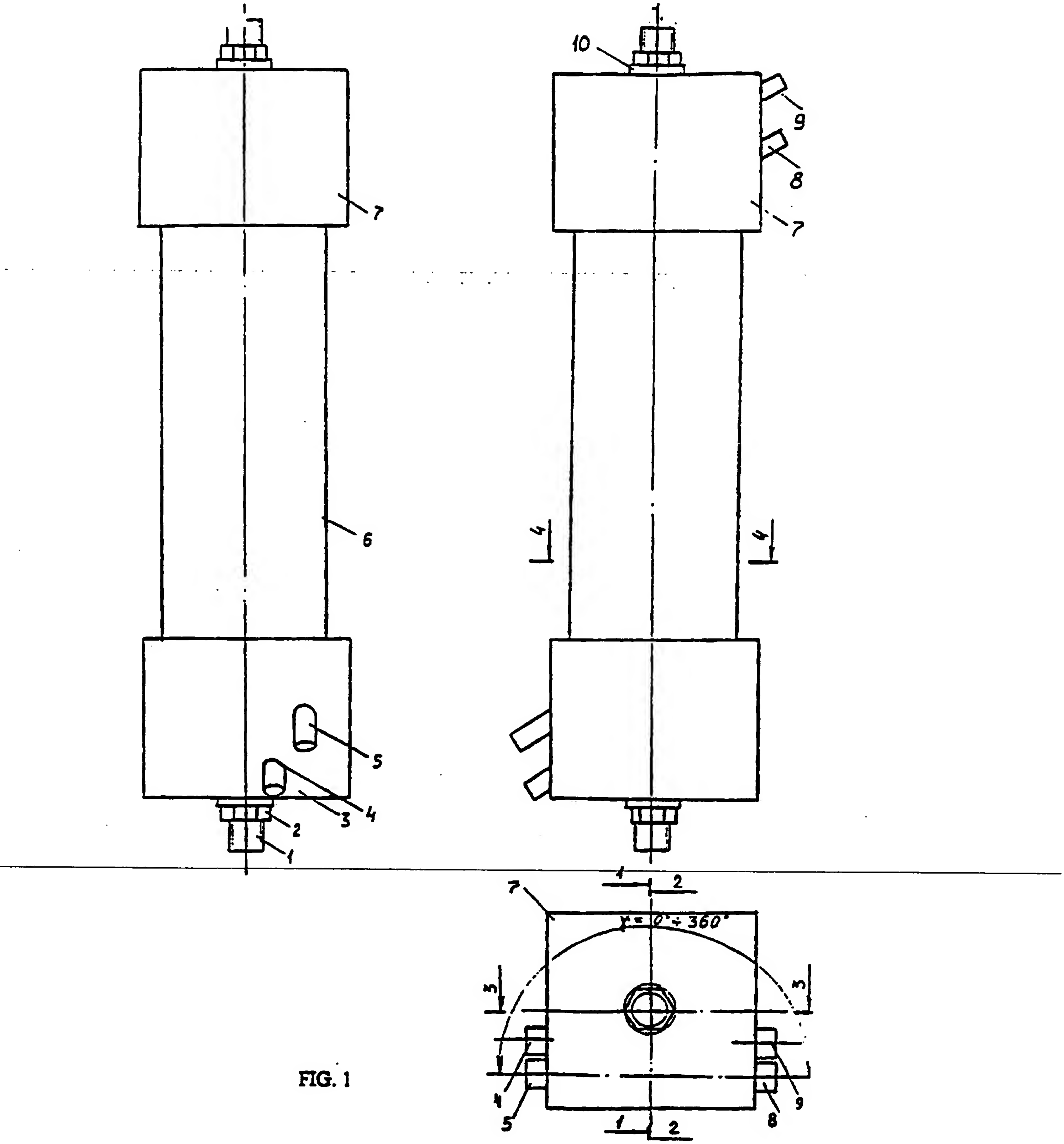

FIG. 1

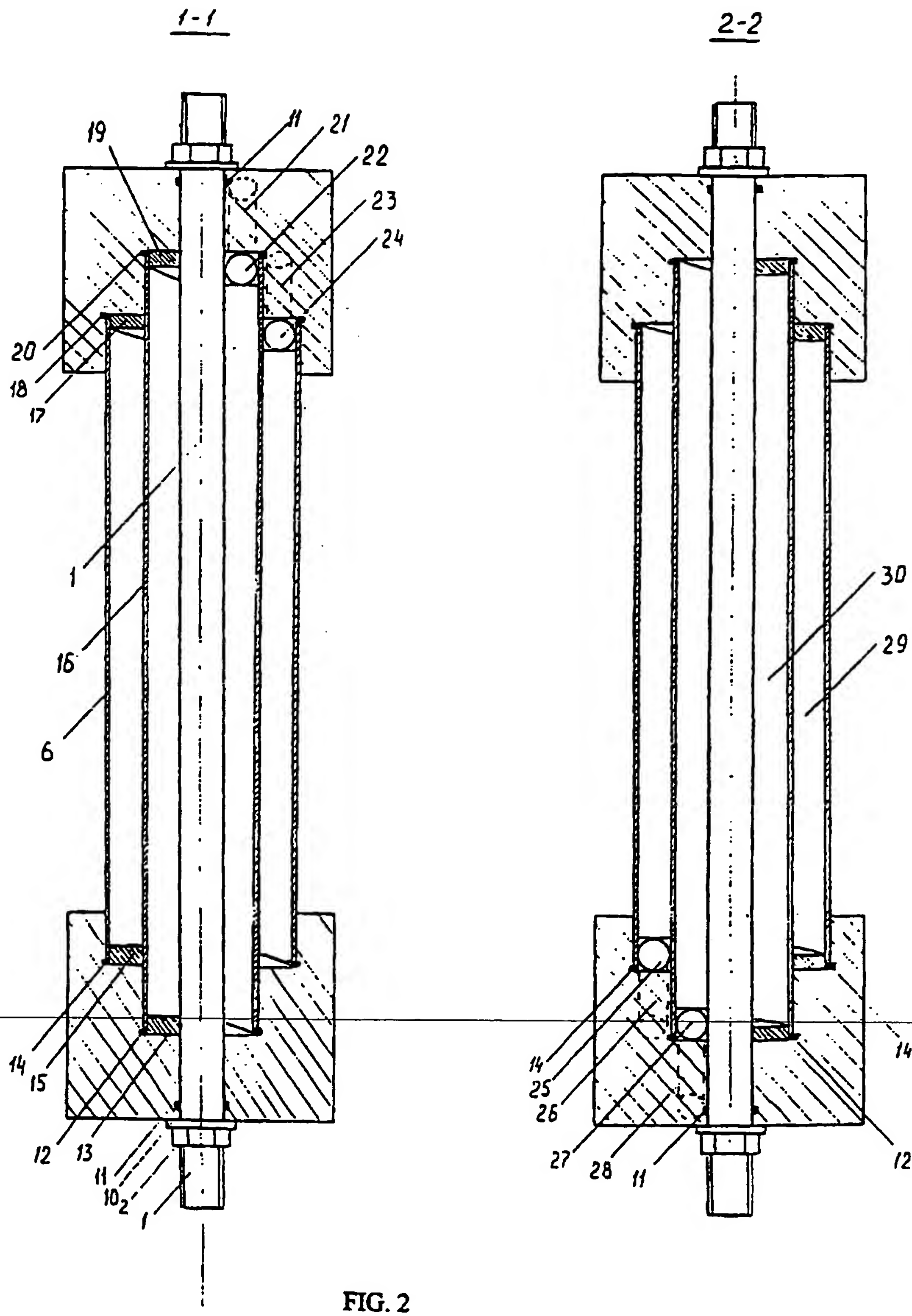
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FIG. 2

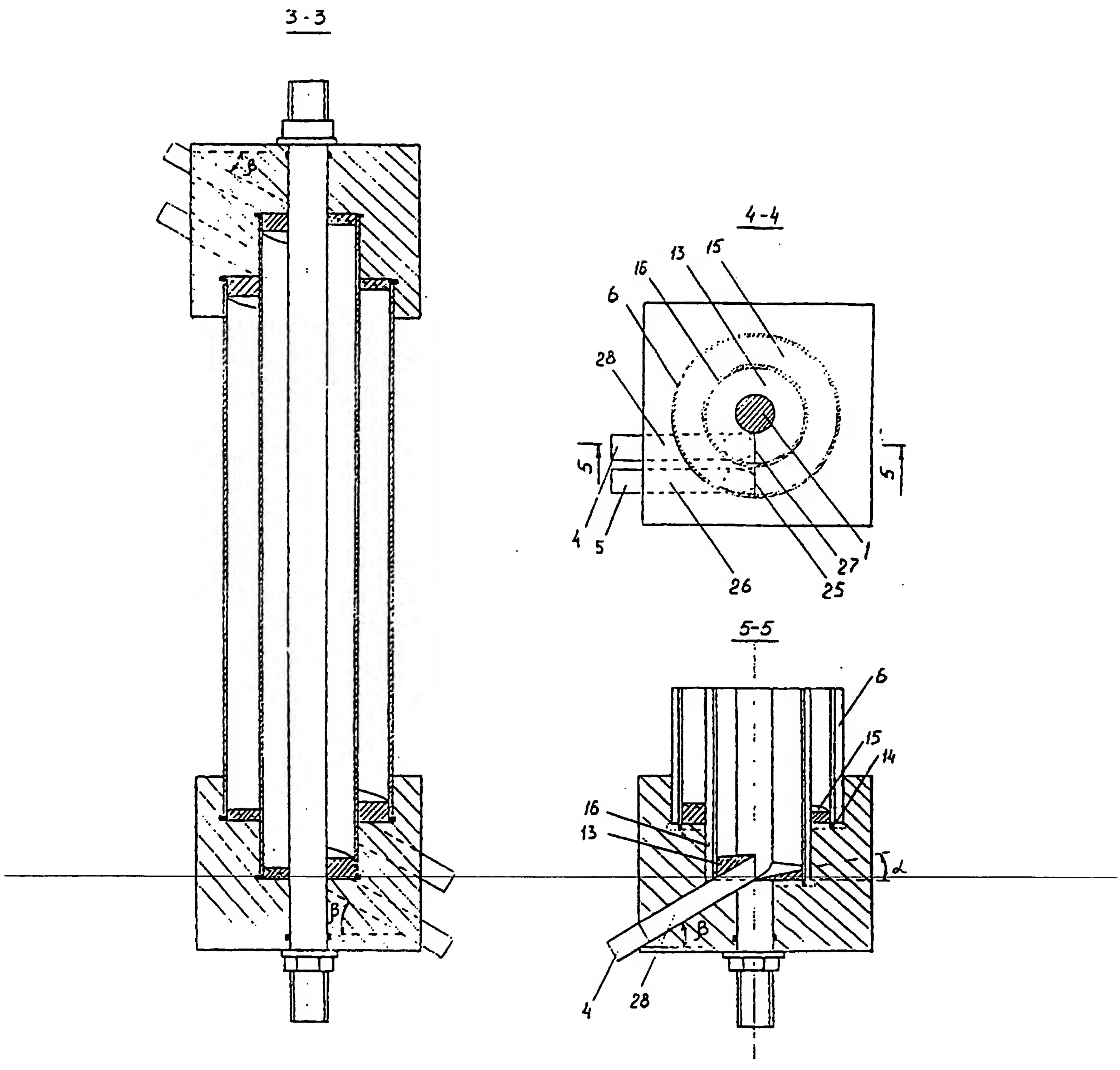

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 97/00281

A. CLASSIFICATION OF SUBJECT MATTER

IPC6 C25B 9/00, C02F 1/461

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6 C25B 9/00, C02F 1/46, 1/461

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SU 1461040 A1 (DZERZHINSKY FILIAL LENINGRADSKOGO NAUCHNO-ISSLEDOVATELSKOGO I KONSTRUKTORSKOGO INSTITUTA KHIMICHESKOGO MASHINOSTROENYA) 10 March 1995 (10.03.95)	1-8
A	SU 1597344 A1 (KAZANSKY KHIMIKO-TEKHNOLOGICHESKY INSTITUT IM. S.M. KIROVA) 07 October 1990 (07.10.90)	1-8
A	SU 1719316 A1 (PROEKTNO-TEKHNOLOGICHESKOE SMETNOE BJURO GOSUDARSTVENNOGO KOMITETA USSSR PO PROMYSHLENNOMU PTITSEVODSTVU) 15 March 1992 (15.03.85)	1-8
A	DE 3341242 A1 (VEREINIGTE ELEKTRIZITATSWERKE WESTFALEN AG) 30 May 1985 (30.05.92)	1-8
A	EP 0300793 A1 (OMCO CO. LTD.) 25 January 1989 (25.01.89)	1-8

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Date of the actual completion of the international search	Date of mailing of the international search report
15 December 1997 (15.12.97)	13 January 1998 (13.01.98)
Name and mailing address of the ISA/ RU	Authorized officer
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Form PCT/ISA/210 (second sheet) (July 1992)